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Lubrication

THIS ISSUE

The Safeguards
of
Lubrication

PUBLISHED MONTHLY BY
THE TEXAS COMPANY
TEXACO PETROLEUM PRODUCTS

"TO ENABLE GOOD LUBRICANTS TO WORK AT THEIR BEST"

EFFECTIVE lubrication presupposes suitable qualities in the lubricants employed.

But that is not all.

The Lubricant must be permitted to operate without any hindrance from outside impurities.

The art of protecting Lubricants is one which is attracting the attention of alert mechanical executives and operators.

Therefore we devote this issue of LUBRICATION to a discussion which is designed to disseminate knowledge which, when thoroughly understood, will enable good lubricants to work at their best.

It is hardly necessary to say that TEXACO Engineers have made a practical study of this branch of lubrication engineering.

For further information (or practical assistance) in this important matter of safeguarding lubrication, call, write or wire and The Texas Company will dispatch a trained lubrication engineer who will gladly cooperate with your plant executive and oil house personnel.

THE TEXAS COMPANY

Texaco Petroleum Products

LUBRICATION

A Technical Publication Devoted to the Selection and Use of Lubricants

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The Safeguards of Lubrication

IN the practice of lubrication of virtually any type of machinery it will be necessary to observe every possible precaution to insure that the lubricants involved will be able to give a maximum of lubrication. In other words, that they will function most effectively in the reduction of friction and prevention of wear between all elements moving in contact with one another.

Protection of lubrication must not cease at the oil house or storage room. It must be observed throughout operation, and in fact, over the entire life of the lubricants involved. And yet, too often will the mistaken idea prevail that care in storage and handling is the gist of effective lubrication. In the plant it may be forgotten, perhaps with due excuse, in the rush of production. But, machine production is directly contingent upon machine efficiency, just as, in turn, the latter is contingent upon the effective prevention of wear and machine shut-down by lubrication.

Lubricants, of course, can only function effectively provided that they are kept as free as possible from contamination during service. They are not impervious to entry of foreign matter, nor to mixing with water or chemicals, although with certain grades the extent to which this may occur will depend upon the degree of their refinement. High grade steam turbine oils for example, will markedly resist emulsification with water, just as properly refined gear lubricants will resist penetration of abrasive matter.

To rely upon the degree of refinement, however, is never positive assurance that such contamination will be satisfactorily resisted. Mechanical means must be provided to prevent the entry of contaminating foreign matter.

The means to use will of course depend upon the design and construction of the moving elements, as well as upon the operating conditions.

Builders of industrial and power plant machinery which may become unduly exposed to objectionable dusts, plant dirt or moisture, have realized the effect which may accrue to their bearings, gears or chains, etc., in event of contaminated lubricants. They have studied means of protection, as applied to bearing design, to the construction of gear and chain housings, and they have developed systems of lubrication in many instances which are virtually automatic and a decided contrast to the practice of but a few years ago.

The ability of their equipment to meet the most intensive demands of production with marked reductions in maintenance and repair costs is evidence of the capabilities of their designing engineers, the wisdom of their foresight, and their appreciation of the problems of operation. The sealed sleeve bearing as applied to the electric motor and the welded lubricant box for servicing electric railway gears are concrete examples of decidedly effective means of lubrication protection. They, along with other devices are shown in the several accompanying illustrations.

Marked service has also been rendered by research authorities in this regard; the studies of Penniman and Karelitz, for instance, having taken full cognizance of the necessity for protection of their lubricants in service, if the results of their experiments were to be dependable.

Bearing Requirements

In the case of bearings it is decidedly essential to have such protection due to the normally low

clearances which will be involved. The sleeve type bearing especially, may suffer in event of abrasive materials finding their way into the clearance spaces for there is normally a considerable area of contact involved, with excellent possibility of recirculation of foreign

Courtesy of Fairbanks-Morse & Co.

Fig. 1—A condition of motor operation where the utmost care must be observed in the protection of bearings, by effective lubrication, and the prevention of contamination of the lubricants.

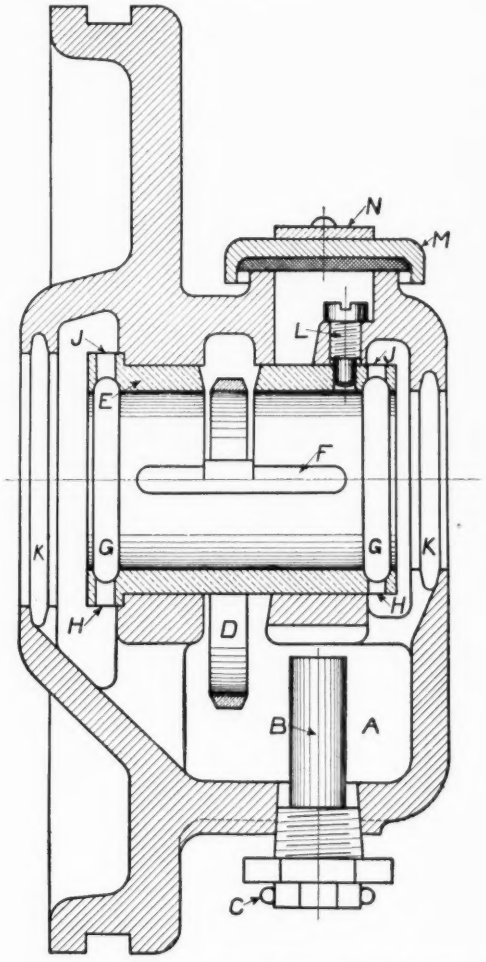
matter once it has gained entry into the lubricating system.

Sliding Contact in Plain Bearings

It is important to remember that the plain or sleeve type bearing involves sliding contact. Therefore, a certain amount of friction must be developed. In the extreme, should metal-to-metal contact occur over the wearing surface of the shaft or journal and that part of the bearing which carries the load, motion at any appreciable speed would develop so much frictional resistance as to very soon necessitate shut-down, for this frictional resistance would cause overheating and expansion sufficiently to seize many such bearings. Under these conditions wear would be decidedly prevalent, and in the presence of abrasive foreign matter, it would occur at a very rapid rate.

An extreme condition as above is fortunately a rarity. Yet it is evidenced every once in a while, for example, in certain of our motor car bearings, where foreign matter has so clogged oil grooves or lubricating leads as to prevent entry and circulation of lubricant.

Effective lubrication is, of course, the most positive preventive, especially where such lubrication can be maintained by the use of uncontaminated lubricants. The automotive and machine tool industries have realized this fact most markedly, continuous filtration of motor and engine oils being especially familiar to all who operate the newer model automobiles, where to a great degree the oil filter is standard equipment. In other words, the manufacturers have appreciated the necessity for safeguarding lubrication.



Courtesy of Manning, Maxwell & Moore, Inc.

Fig. 2—Another type of ring-oiled motor bearing. Note "A" the oil well; and "B" a standpipe overflow located at the center of the bearing where oil level is least disturbed. This device can be screwed into the bottom of the bearing; its removal therefore, affords means of draining. Under severe conditions of possible dirt or dust contamination, a flap cover "C" is provided. "D" is the oil ring; "F" a longitudinal groove for oil distribution; "M" is the shrouded cover with felt lining to insure a dust-tight fit; and "N" is a flat spring to keep cover in tightly closed or extreme open position.

To be sure, such equipment may involve additional initial expense, but the insurance of more dependable lubrication with the marked probability of a decided increase in the life of the bearings involved, should prove highly acceptable.

METHODS OF OIL PROTECTION

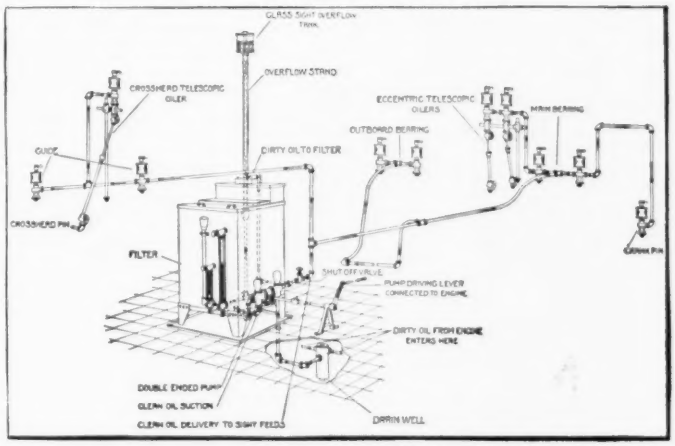
Automatic oil filters or purifiers are, however, only adaptable to circulating oiling systems. With individual lubricators, the best we can do is provide for insertion of perhaps a piece of felt or wicking in the oil feed. More detailed discussion of the construction and principles of operation of each will of course be of interest.

Bulk Filtration

Where a considerable volume of oil is involved, as for example in the operation of the steam turbine or Diesel engine, filtration, whether it be continuous or performed at intervals, may be regarded as bulk treatment of the oil.

Filter Construction and Operation

The modern industrial or power plant oil filter will in general provide for combined precipitation and filtration. The oil as received from the lubricating system, etc., is run to a removable strainer box to take out any larger, heavier particles of foreign matter. From the strainer box it generally passes to a heating tray; especially if it is a heavier, more viscous product, in order to promote subsequent precipitation and separation of as much water and sludge as possible.



Courtesy of S. F. Bowser & Co., Inc.

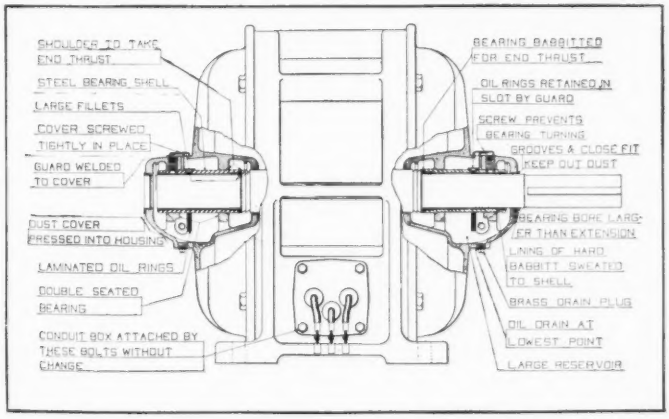
Fig. 4—Arrangement for pressure lubrication of engine or compressor bearings. Note the oil filter, the individual sight oilers and the extent to which complete positive and cleanly lubrication can be maintained.

After suitable heating the oil is led to the base of the filter, passing thence upward into the precipitation compartment over a number of precipitation trays at comparatively low velocity. By staggering these trays and giving a zig-zag path to the oil more effective precipitation is accomplished over the time available. Foreign matter naturally settles to the bottom of the trays; water is led off through by-passes to the bottom of the compartment to prevent it being carried through to the filters.

Precipitation Not Entirely Effective

Precipitation alone is an extremely lengthy proposition, though dependent of course upon the viscosity of the oil and the amount of foreign matter contained. Normally, too much time would be necessary for proper clarification of an oil. The rate of precipitation can be expedited by heating the oil to a certain extent to reduce its body, or by addition of certain substances which differ sufficiently in specific gravity, to increase the rate of settlement of the contained impurities. Over the period of precipitation the oil should of course be as quiet as possible, for agitation to any extent would obviously interfere with settlement of material heavier than the former.

In consequence, precipitation is generally resorted to only for partial clarification or removal of larger and relatively heavier particles of foreign matter. Final treatment is carried out by filtration or screening the oil through porous material with openings fine enough to retain the majority of the remaining impurities. Wire cloth or finely woven canvas serve this purpose satisfactorily. The extent to which ultimate purification will be attained will depend upon the length of time


SHOULDER TO TAKE END THRUST
STEEL BEARING SHELL
LARGE FILLETS
COVER SCREWED TIGHTLY IN PLACE
GUARD WELDED TO COVER
DUST COVER PRESSED INTO HOUSING
LAMINATED OIL RINGS
DOUBLE SEATED BEARING
CONDUIT BOX ATTACHED BY THESE BOLTS WITHOUT CHANGE
BEARING BABBITTED FOR END THRUST
OIL RINGS RETAINED IN SLOT BY GUARD
SCREW PREVENTS BEARING TURNING
GROOVES & CLOSE FIT KEEP OUT DUST
BEARING BORE LARGER THAN EXTENSION
LINING OF HARD BABBITT SWEATED TO SHELL
BRASS DRAIN PLUG
OIL DRAIN AT LOWEST POINT
LARGE RESERVOIR

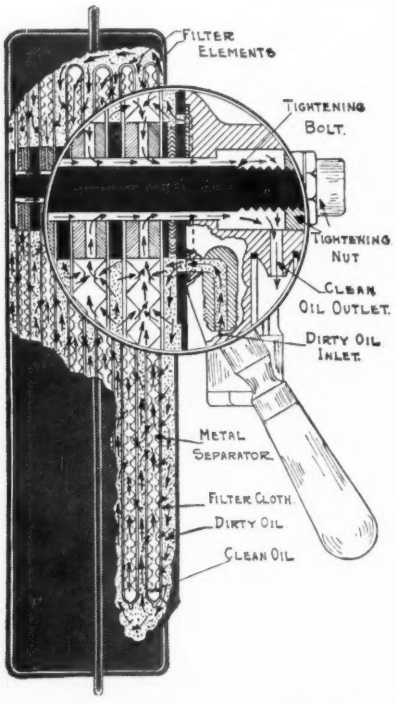
Courtesy of General Electric Co.

Fig. 3—Sectional view of the bearings and housing of an induction motor showing in particular the provisions for protection of lubrication. Note the dust cover pressed into the housing and the grooves installed to keep out dust.

the oil is treated and the fineness, weave or density of the filter.

Reconditioning Dependent Upon Service

It is not usually necessary to attempt to bring an oil completely back to its original state



Courtesy of Motor Improvements, Inc.

Fig. 5—Details of the Pur-o-lator continuous unit oil filter. This device involves filter cloth elements through which the oil is passed. Note the several component parts indicated on the illustration.

of purity. Too much time and too intricate equipment would be involved. The extent of reconditioning should be based upon the grade of oil under treatment and the service it must do. Obviously steam turbine lubricants would require more careful treatment than car oils; the requirements imposed are in general more severe.

As a result, after the oil has been freed of heavier foreign matter by precipitation it is passed to the filter compartment. In this latter in rigid arrangement are the filtering units. Metallic frames covered with finely woven filter cloth or wire mesh are used for this purpose. By locating them in vertical position, accumulation of deposits on the filtering surfaces is reduced, such matter dropping to the bottom of the compartment. Frequency of cleaning filters is thereby extended, and they are better able to efficiently perform their intended functions.

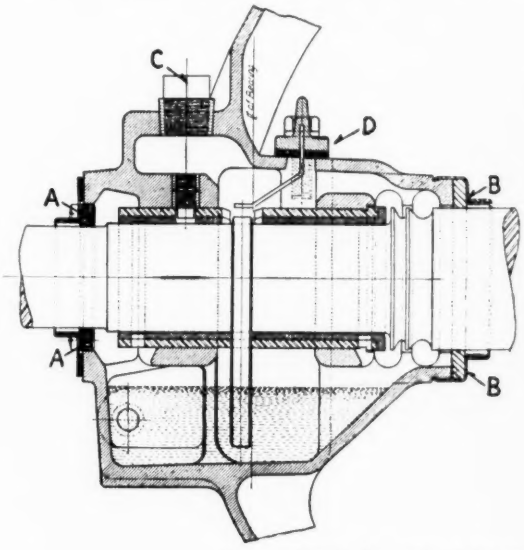
Filter material should be non-corrosive, as resistant to abrasive wear as possible, inexpensive, easy to install, non-soluble in oil, of such a weave as to give a uniform rate of filtration over the entire surface, and it should have no tendency to give off shreds or disintegrate in any way to perhaps contaminate the reconditioned oil.

Continuous Unit Filtration

Where smaller type devices are employed, involving strictly filtration of the oil in service, the operation is usually continuous, the entire volume of oil being passed through the filter in its circulation. The automotive oil filter is typical of such equipment.

Effective filtration or purification of automotive engine oils in service can be expected to lead to the same beneficial results in improved lubrication, as similar treatment of steam turbine or Diesel engine oils. Defective lubrication is more frequently the result of contaminated lubricants, and the inability of the latter to perform their intended function, rather than of faulty refinement, provided of course that the original oil conforms in characteristics to the specifications demanded by engine construction and the operating conditions involved.

To therefore endeavor to protect the automotive engine by removal of dust, dirt or



Courtesy of Westinghouse Elec. & Mfg. Co.

Fig. 6—Details of the Westinghouse sealed sleeve motor bearing. "A" and "B" are soft felt washers which serve as bearing seals. "C" is a plug to prevent entry of dirt via the oil filling hole. By removal of this plug the ring can be inspected. "D" is a cover seal which closes the opening through which the oil ring is admitted. Note that it is packed to insure against possible entry of foreign matter.

metallic foreign matter from the oil, is decidedly advisable.

Clean Air An Adjunct

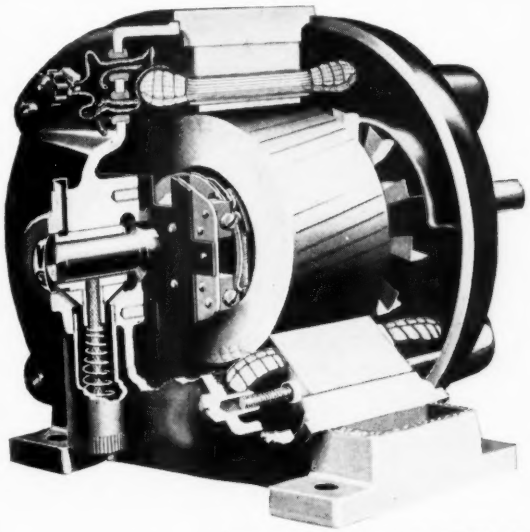
The air filter if properly designed should remove the greater part of any fine abrasive

dust that might be carried in by the air which is essential to combustion. But this air is not the only source of contaminating foreign matter. Road dust may gain entry via the crankcase breather; metallic particles may be abraided from bearings, cylinders or piston rings, especially in a new or re-bored engine or one where bearings have been renewed; or careless handling in filling fuel tanks might easily result in dirt dropping into the tank, to possibly find its way ultimately to the engine. The same would hold true were motor oils to be added from dirty containers or handled in a careless, sloppy manner.

In consequence, faulty lubrication of bearings and cylinder walls might easily result, with scoring, abrasion or even burned out bearings, were oil lines to become clogged.

The properly designed oil filter should prevent this. To expect, however, that the oil filter as applied to individual treatment of automotive engine oils will insure indefinite longevity in the latter is erroneous. For the oil filter cannot be absolutely perfect, nor can it adequately remove that very fine carbonaceous content which is the natural result of subjecting such oils, today, to the usual temperatures of combustion.

Oils do not break down, but there is a tendency towards incomplete combustion of oil



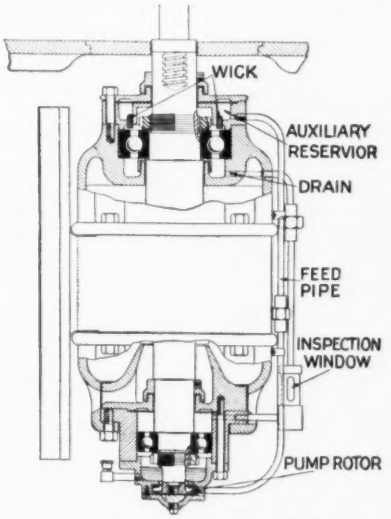
Courtesy of Westinghouse Elec. & Mfg. Co.

Fig. 7—Showing an up-feed type of wick-oiled bearing as applied to an electric motor. Construction involves a combined wick guide and steady pin to insure that the wick rests against the shaft. Oil which works out at the end of the bearing is returned to the oil cup below via a suitable return passage.

and gasoline to a certain extent. The residue, being carbon, is of naturally a discoloring nature, hence the rapid darkening of the new oil when put into service. Furthermore, carbon has but a negligible lubricating value; in fact, if hard and abrasive, it may easily lead to scoring of wearing elements.

Make-up Oil Always Necessary

As a result, motor oils require the addition of make-up. Furthermore, however effective



Courtesy of S. K. F. Industries, Inc.

Fig. 8—Showing the lubricating system for a high speed vertical spindle shaper. This is a system of circulation lubrication using a small centrifugal pump in the lower reservoir to feed oil to the upper ball bearing via a suitable wick. From here oil drains to the lower bearing reservoir to be similarly distributed by a wick. It finally returns to the pump for recirculation.

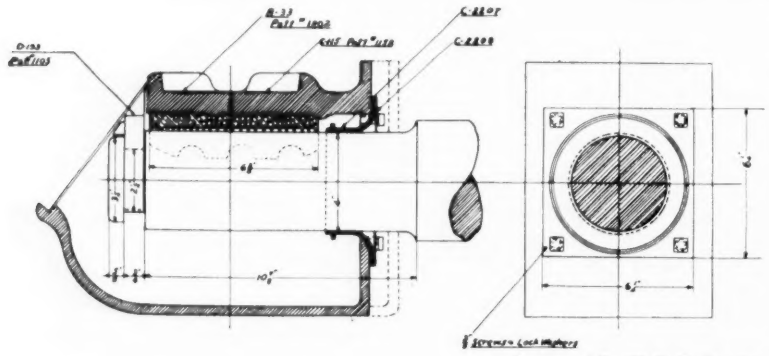
the engine oil filter, they require frequent replacement, in the interests of protection of the more valuable engine wearing parts. Too, we must remember that oil filters in service are constantly accumulating solid foreign matter. To an extent this will improve filtering efficiency. Rate of oil flow will be reduced, however, dependent upon the thickness of the deposit. Ultimately filtering efficiency will likewise be affected. Filters must, therefore, never be regarded as eliminators of the necessity for periodic crankcase draining, although in efficient condition they may rightly be expected to lengthen this period and increase the mileage value of an oil to a certain extent.

Centrifugal Treatment

Where a considerable volume of oil is involved, it is also practicable to employ centrifugal treatment for the removal of abrasive or non-lubricating foreign matter. As a general rule, centrifugal purification is a more rapid process than filtration, and quite as readily employed for continuous or batch treatment of turbine or Diesel engine lubricants.

Separation of substances or fluids of different specific gravity can be effectively brought about by centrifugal force, in a comparatively short period of time, due to the intensity of the force involved. As in the case of precipitation,

moderate heating is an adjunct to effective separation by centrifugal force, due to the resultant reduction in viscosity of the oil under treatment. The extent of heating necessary would of course depend upon the viscosity of the oil, and to a certain degree upon the amount of contamination. Obviously a light turbine oil would not require as much heating as a relatively heavy Diesel engine oil.



Courtesy of Dr. W. B. D. Penniman

Fig. 9—Improved car-wheel journal box construction as developed for the United Railways and Electric Co. of Baltimore. Here a leather oil seal capable of adapting itself to the varying position of the journal and bearing has been found to be extremely satisfactory as a preventative against entry of dirt or water.

Separator Construction

The typical centrifugal separator consists of a rotating bowl or cylinder contained within a suitable frame or housing. Oil to be treated is delivered to the lower part of the bowl. When the latter is rotated metallic particles, dirt, sludge, water and oil are separated according to their relative specific gravities, solid matter being thrown to the sides or walls of the bowl. The water and oil are carried upward to be caught in suitable covers which are fitted with spouts for discharge to drain or clean oil tank respectively.

Wick Feed or Siphon Lubrication

In order to attain the positive results of sight feed lubrication as well as certain of the economies of waste pad lubrication, with the attendant advantages of oil filtration, the use of wicks to transmit or siphon oil from a reservoir or manifold adjacent to the bearing into the oil ducts is often resorted to.

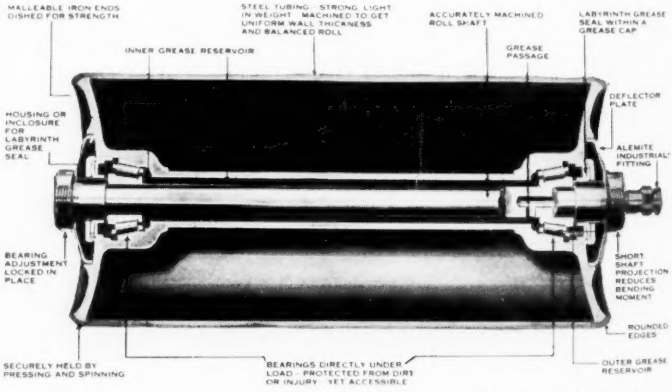
This device in its basic form is perhaps one of the simplest yet most effective types of relatively automatic lubricating, and filtering media in use today. Especially in the marine service has it made its mark, though naturally it requires more attention on shipboard where compounded oils may be used.

In view of the above it has been only natural that engineers should have directed their efforts towards the development in the industrial and automotive fields of variations of the original idea of wick feed lubrication.

While the design of these various types has differed more or less from the basic idea, the principle of operation is essentially the same, involving either capillary attraction, or a combination of this latter with the action of the siphon. The former is present in the up-feed type of lubricator, wherein the oil passes upward through the pores of the wick of its own accord, motion of the journal being required to draw the oil away from the uppermost portion of the wick with which it is in contact.

This type of wick feed oiler is absolutely automatic in that oiling starts and stops with the starting and stopping of the shaft or journal. Therefore, there is no chance of wastage of oil during shut-down periods; yet the wick remains saturated and ready for immediate service just as long as there is oil in the reservoir.

Where the action of the siphon is included in the design of any wick feed lubricator, however, or where oil feed is downward, some provision must be installed to stop the flow of lubricant over periods of shut-down, or else the wick must be withdrawn from the oil lines; otherwise the oil in the reservoir will continue to flow until it has all been siphoned over to the bearings. Naturally, this would be a direct waste. This has been realized by industrial and automotive engineers, with the

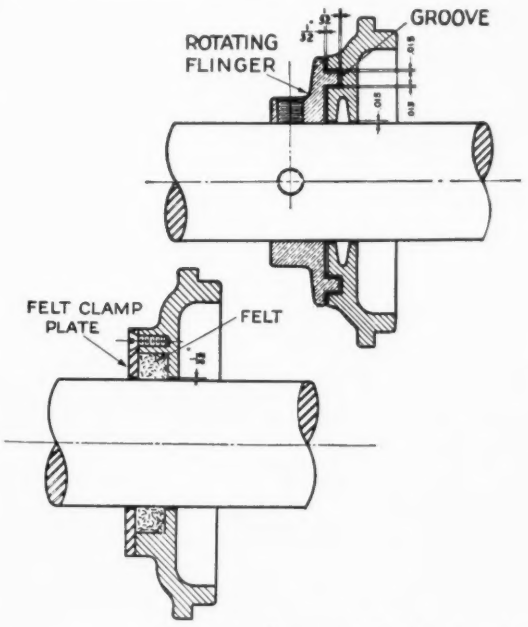

MALLEABLE IRON ENDS DISHED FOR STRENGTH
STEEL TUBING - STRONG - LIGHT IN WEIGHT - MACHINED TO GET UNIFORM WALL THICKNESS AND BALANCED ROLL
ACCURATELY MACHINED ROLL SHAFT
LABYRINTH GREASE SEAL WITHIN A GREASE CAP
INNER GREASE RESERVOIR
GREASE PASSAGE
DEFLECTOR PLATE
HOUSING OR INCLOSURE FOR LABYRINTH GREASE SEAL
ALEMITE INDUSTRIAL FITTING
BEARING ADJUSTMENT LOCKED IN PLACE
SHORT SHAFT PROJECTION REDUCES BENDING MOMENT
ROUNDED EDGES
SECURELY HELD BY PRESSING AND SPINNING
BEARINGS DIRECTLY UNDER LOAD - PROTECTED FROM DIRT OR INJURY - YET ACCESSIBLE
OUTER GREASE RESERVOIR

Courtesy of Link-Belt Co.

Fig. 10—Details of an anti-friction belt conveyor idler roll, equipped with Timken tapered roller bearings. Note the respective parts and particularly the provisions for grease sealing of the bearings.

result that they have developed certain types of wick feed lubricators which are practically automatic in action, requisite of a minimum of attention, decidedly economical as regards the matter of oil consumption, and quite effective oil filters.

In design a wick feed system consists of a manifold or oil storage reservoir, which is usually located as part of the bearing or unit to be lubricated. With the manifold or marine type there is connection via brass pipes to the various parts to be served, the manifold ends of these pipes projecting through the bottom of the tank to within an inch or two of the top. They should always be above the oil level. The lubricant is fed into these pipes by means of wicks of worsted yarn. At one end of each wick is usually attached a lead sinker, the other end being wound around with wire. The weighted end during operation is immersed in the oil in the manifold, the wired end leading into the oil feed ducts. As a result, the oil is able to pass up through the strands of each wick by capillary action of the latter, working

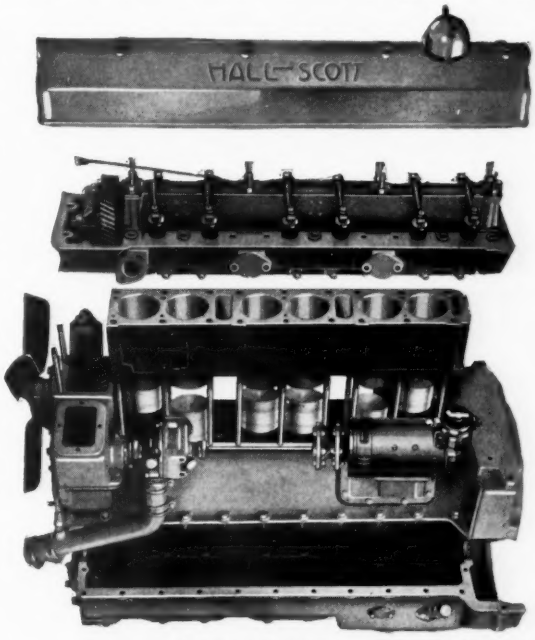


Courtesy of S. K. F. Industries, Inc.

Fig. 11—Showing the methods of sealing anti-friction bearings. At the lower left is shown the usual form of felt washer seal. A compressed cork ring instead of the felt washer can be satisfactorily used if desired. At the upper right is a labyrinth type of seal which is advantageous where an excess of dust or abrasive matter must be guarded against.

its way up over the top of the oil duct, to subsequently drop from the wired end of the wick and be distributed to the particular bearing involved.

Wick lubricators involving siphon action are adjusted or controlled by changing the oil level, the number of strands of wick used, or varying the pressure on the wick. Furthermore, starting and stopping of the oil flow is contingent upon the position of the wicks, i.e., when inserted in the distribution pipes, oil will flow continuously regardless of whether the machine is operating or not. Some designs of wick



Courtesy of American Car & Foundry Motors Co.

Fig. 12—Details of the Hall-Scott engine showing manner in which dust-tight assembly of the five separate sub-assemblies can be brought about. Note details of the crank-case part of the oiling system.

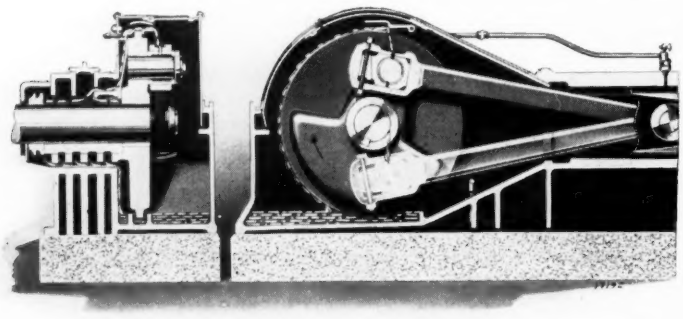
oilers, therefore, have stop cocks inserted in the oil distributing lines.

Care in Operation

Perhaps one of the most important features in the attainment of automatic lubrication by means of wick feeds is the care they receive during operation. With the marine type lubricator, oil flow can only be positive and automatic if the wicks are removed from the system at frequent intervals, and pulled or stripped through the fingers in order to prevent the oil from gumming or hardening within the strands; this is especially true where compounded oils are used. Such formations would, of course, tend to clog the oil pipes and retard lubrication. It is also advisable to use comparatively shallow reservoirs, both to facilitate siphoning action by reducing the height over which the oil is to be lifted, and to prevent deposits from collecting in the bottom.

The number of strands to be used in a wick is also a factor. For example, if too many are used or if the wick is too heavy, we will not obtain effective capillary action. As a result, wick feed lubrication in general requires con-

siderable intelligence in its application, and it should not be used without due consideration of the machinery involved and its adaptation to operating conditions.



Courtesy of Ingersoll-Rand Co.

Fig. 13—View of the lubricating system on the crank end of an air compressor. Positive lubrication by flood circulation is brought about by the dipping action of the rotating crank. The housing effectively prevents entry of contaminating foreign matter. Oil level as well as path of oil during circulation is clearly shown.

It is also important to remember that new wick strands when exposed to the air tend to absorb moisture. This is a detriment to effective capillary attraction, inasmuch as moisture impedes the ultimate free flow of oil. All wicks should therefore be thoroughly dried prior to usage, and then saturated with oil.

It may be safely stated that within the limitations of their adaptability, the efficiency of wick feed lubricators will depend to a large extent upon the original purity of the oil used and the cleanliness of the system. For example, dirt in the oil reservoir or the use of a cheap, low-grade oil which may contain contaminating foreign matter to any extent, may easily result in the ultimate cessation of lubrication.

It is perfectly true that the wick serves as a filter to insure the transmission of clarified oil to the bearing. On the other hand, if we clog up this filter with dirt, carbon, or other non-lubricating matter, it naturally follows that the passage of oil will thereby be reduced or even stopped.

Therefore, the grade of oil used in any type of wick feed oiler may be said to be in part indicative of the ultimate success we may expect from such a device; provided the basic principles of construction are correct and the size of the oiler is adequate for serving the bearing in question. Under these conditions if a highly refined lubricant free from foreign matter is used, there is no reason why the lubrication attained therefrom should not be practically automatic.

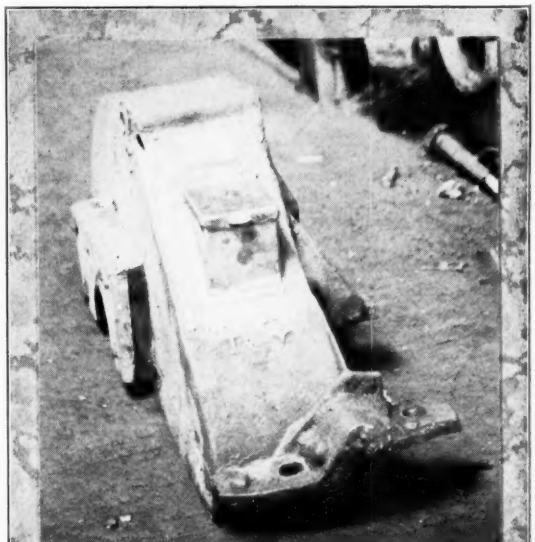
Anti-Friction Bearings

In the case of the anti-friction bearing, the area of bearing contact will be decidedly less than in a plain bearing. For this very reason, however, the presence of abrasive foreign matter in the lubricant may be more serious than with a plain bearing. In the latter the surface of the shaft, journal or bearing may readily become scored to a marked extent, and yet the clearance may not be so uniformly increased as to develop pounding or extensive misalignment.

Abrasion of balls, rollers, or raceways, however, may be a different story.

The presence of fine abrasive matter in a lubricant for such service will convert this latter into an excellent lapping compound which will readily cause wearing of the rolling elements. The extent of such wear, however, will depend upon the operating speed.

Fine abrasive matter, on the other hand, has been found to cause but little actual pitting. This latter is more nearly the result of the presence of coarse abrasive matter in the lubricant. Pitting will cause rapid deterioration of such bearings.



Courtesy of Electric Traction, and the West Penn Railways Co.

Fig. 14—Showing an effective method of insuring street railway gear lubrication by means of a lubricating box welded onto the gear case. The gear case, below the box, is drilled for a ⅛ inch hole to permit of dripping of the lubricant to the gear teeth as they pass into mesh. A spring cover top effectively prevents entry of external foreign matter.

Take for example the ball bearing, electric motor, operating in a cement mill. Here, development of excessive wear and abrasion, should the bearing housing be such as to permit entry of dust, might very probably lead to the rotor

or armature coils coming in contact with the pole pieces of the stator to cause a burnout.

Prior to such an extreme there would, of course, be inefficient operation. Wear of anti-friction bearing elements must, therefore, be watched very carefully, for we must realize that their construction involves theoretical point contact in the ball bearing and line contact in the roller. The surfaces are extremely hard, steel being involved throughout, in contrast with the softer bearing metals as used in plain bearing practice. But steel is not immune to abrasion, especially where the abrasive is of silicious nature and where more or less continuous action takes place. Furthermore, once our theoretical point or line contact is converted to area contact, perfect rolling of the balls or rollers may give way to a certain amount of sliding, which would tend to increase the rate of wear.

INDICATIONS OF WEAR

The general indications of such wear as may result from impaired lubrication due to abrasive-contaminated lubricants, will be overheating and noise.

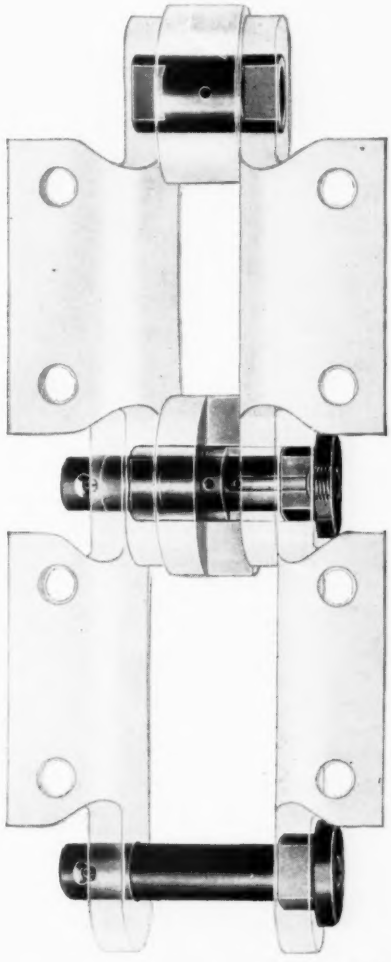
In Bearings

In the case of bearings increase in operating temperature can safely be regarded as a positive indication of the occurrence of abnormal solid or semi-solid friction due to more or less actual contact between the bearing elements or the presence of solid foreign matter within the clearance space.

The development of noise, however, will usually only occur where wear has been excessive and continuous over a considerable period of operation. In such instances it will be due to marked increase in the clearance space, which will enable the shaft or journal in question to develop an appreciable amount of lateral motion in its rotation. The result of the above would be a pounding noise. This action may become decidedly serious, for the bearing metal may often be pounded out of place, temperatures may rise even to the extent of melting of this metal, and the resultant misalignment of shafting may impair the operation and increase the power consumption of adjacent (connected) machinery to a marked degree.

It is impossible to overcome such a condition by the simple expedient of resorting to a heavier bodied lubricant. To a certain extent the increased viscosity will enable the formation of a lubricating film of greater thickness. But it cannot compensate for the wearing action of abrasive foreign matter. Just as long as the latter can gain entry, wear will occur, regardless of the lubricating ability of the oil or grease being used.

The obvious solution is, therefore, to study constructional and operating conditions to determine how and to what extent such abrasive foreign matter is gaining entry. Then means should be provided to prevent this. In some instances it may mean the installation of sealing media, such as Dr. Penniman developed in his study of electric railway journal bearings. In others, merely resorting to more improved means of lubrication or the substitution of grease for oil will solve the problem. The advantages of grease as a sealing media will be discussed later.

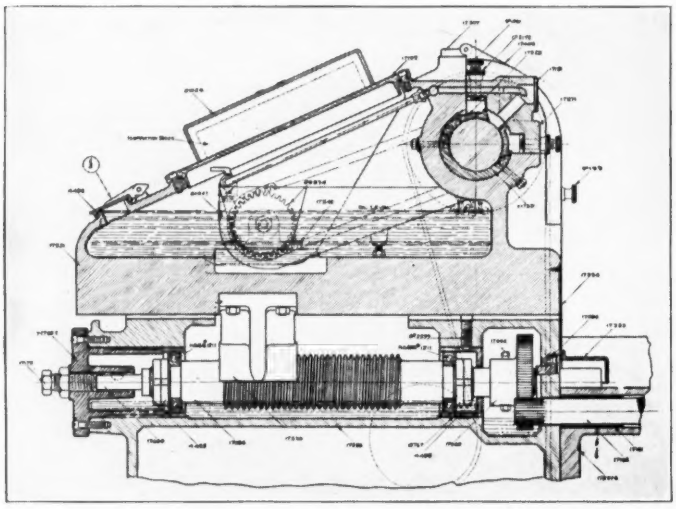


Courtesy of Link-Belt Co.

Fig. 15—Phantom view of a steel conveyor chain showing provision for Alemite pressure grease lubrication. In this way clean, fresh lubricant can be forced completely through each link connection to free the clearance space of used product, as well as to maintain a seal against entry of dust, dirt or grit. This type of chain is extensively used in the sugar industry.

With Gears and Chains

Noise, on the other hand, is the primary indicator of wear, in the case of gears and driving chains. As a general rule, there will be considerably more possibility for ventilation than prevails with the average bearing. In consequence, increase in operating temperatures will usually not be as marked, even in extreme cases of faulty lubrication of gear teeth or chain link connections, for radiation will serve as an effective means of temperature reduction.



Courtesy of Norton Co.

Fig. 16—Cross section of the wheel slide of a grinding machine. Note the details of the chain driven oil pump, feed screw and spindle bearing. The oil levels, as well as the flow of oil from the pump, is shown by shading and arrows. The entire case is so effectively sealed as to insure remarkable protection of the oil in service. A suitable filter, adjacent to the pump can be installed as an added protection.

Furthermore, whereas, it is in many cases practicable to test the temperature of a bearing by hand, with a gear or chain, this practice would be hazardous, and even if possible would be no criterion of the probable actual temperature at the wearing surfaces.

Development of noisy, clanking operation, however, is a decidedly positive indication that a gear or chain lubricant is not functioning as it should, in the prevention of metallic contact and solid friction.

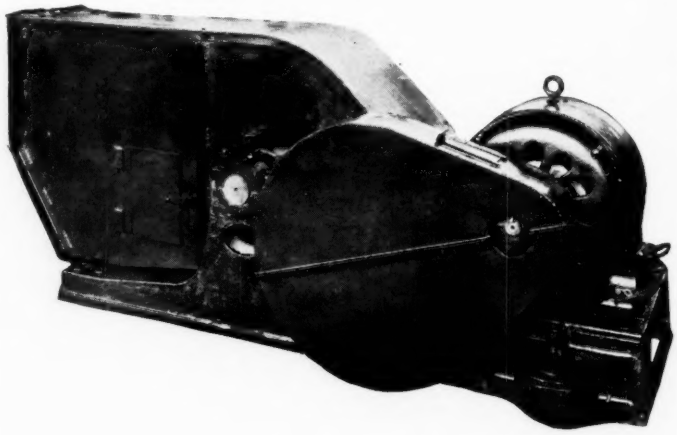
It will be of interest to note that with gears especially there will be periods over which the lubricant will be inactive, for actual friction between the teeth will only occur when they are in mesh. To a somewhat less extent the load imposed upon a chain link connection will also be decreased over the period of slack operation.

Chain lubrication, on the whole, is akin to bearing lubrication in the requirements which will be imposed upon the lubricants. There is, however, more chance for lubricant to be thrown off from a chain link than from the average line shaft, engine or industrial machine bearing, for even though certain of the latter may be themselves subject to rotary or reciprocating motion, this will not be as severe as the action of centrifugal force involved in a chain installation. The effect of centrifugal force must be especially considered in the lubrication of exposed or semi-enclosed chains. Centrifugal force will, of course, be greatest during the period of articulation or bending, as the chains pass over their sprockets. At such times any lubricant on the outside surface of a chain may be thrown off, although this will depend upon the adhesive ability of the lubricant and the peripheral or surface speed of the sprockets.

The Essentials in Chain Lubrication

There are, therefore, two primary steps which must normally be followed in the safeguarding of driving chain lubrication, viz.:

1. The selection of a lubricant of adequate viscosity and adhesive ability, commensurate with the manner of housing and the method of application, and
2. Application of this lubricant over the



Courtesy of Link-Belt Co.

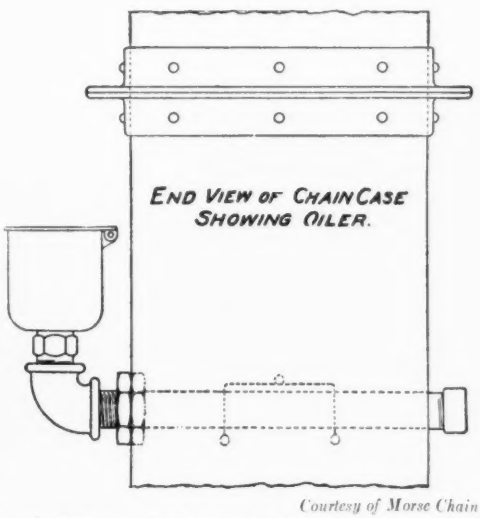
Fig. 17—Assembly drive unit for a shaker conveyor, showing how completely such a device can be housed to prevent entry of contaminating foreign matter.

inner or more active wearing surface, in order to insure as complete penetration as possible to the link connections before the lubricant has a chance to work its way to the outside surface of the chain from which it may be thrown off.

Of course, these points will apply more strictly to the exposed or semi-enclosed chain drive, i.e., the installation wherein there is but little or no provision for automatic lubrication. Where a driving chain is subject to a constant supply of lubricant as is the timing gear drive in some automotive engines, or those enclosed industrial chains which are fitted with oil pumps and suitable piping for circulation of oil from a base reservoir, maintenance of lubrication is normally positive, and only requiring of an adequate supply of properly refined lubricant.

A carefully designed housing is a most important feature in the safeguarding of lubrication of any chain. By virtue of link construction the wearing effect of abrasive foreign matter may rapidly become very serious. In fact, it is virtually impossible to offset this, however suitable the lubricant may be.

Entry of such dust, dirt or metallic particles as may lead to wear through contamination of the lubricant must therefore be prevented wherever possible. The oil-tight housing is the most practicable solution of this problem, and it should be used wherever operating conditions may be severe.

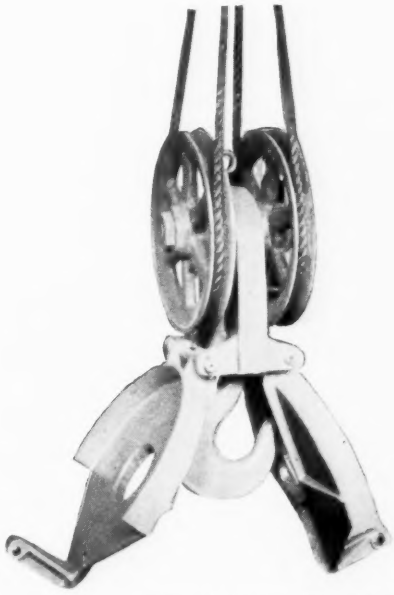


Courtesy of Morse Chain Co.

Fig. 18—End view of a chain case designed for a silent chain drive showing means provided for automatic oiling. With this device drip feed of clean, fresh oil to the inside chain surface is brought about. An oil bath is thereby eliminated.

GREASE AN EFFECTIVE BEARING SEAL

One of the outstanding advantages of grease as a lubricant is its ability to serve as a safeguard by reason of the virtual seal which can be developed.



Courtesy of Manning, Maxwell & Moore, Inc.

Fig. 19—Showing a method for guarding the sheaves in a wire rope installation. Personal hazard is thereby reduced. Furthermore, contact with abrasive foreign matter is reduced at the point where it might do the most harm, viz.: where the ropes bend to permit of more ready penetration of the lubricant.

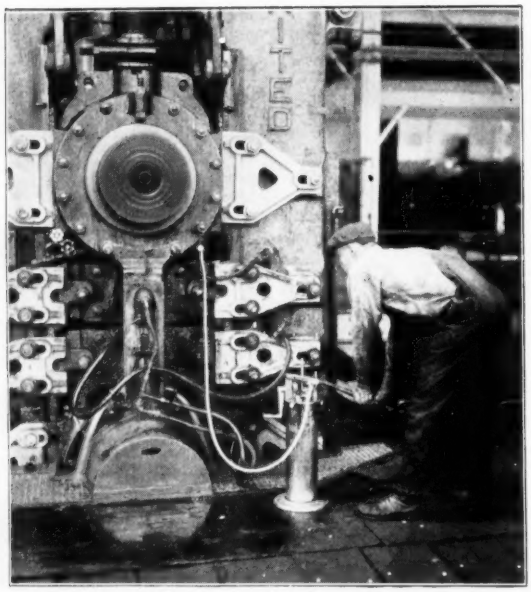
Visible indication of such a seal will be possible in the lubrication of certain types of plain bearings, especially where journal or shaft ends are exposed. This will of course hold true for some types of chain links as well, although the maintenance of such a seal may not be as practicable as in the case of the pressure lubricated shaft or journal bearing.

On the other hand, visible indication of a grease seal is not essential. Take the antifriction bearing for example. Here grease is very frequently preferred to oil for the very reason that a more effective seal is derived. And yet it is only practicable to estimate how much lubricant to use. Normally with such a bearing it will be inadvisable to fill completely with grease, for complete filling is no assurance of any more effective lubrication, and furthermore an increase in internal friction within the lubricant itself may be developed. With due care, however, it is perfectly practicable to determine the approximate grease requirements of such a bearing and, with a hand gun especially, the amount ejected per turn of the handle, for example, can be ascertained. With such information such a gun can be used

quite intelligently and with assurance that over-lubrication is not being carried out.

In the Automobile Spring Shackle

Perhaps the most forcible example of the grease seal is presented by the plain bearing spring shackle in so many of our automobiles today. Grease lubrication of such bearings by means of the pressure gun and a suitable fitting or lubricator has adequately stood the test of time. It involves care and attention, however, for the parts in question are subjected to severe service, involving repeated shock and frequently operation in the presence of abrasive dust, rain, mud, snow or ice.



Courtesy of McGraw-Shaw Co., and The American Rolling Mill Co.

Fig. 20—Method of assuring positive and cleanly lubrication of the roll bearings of a four-high mill. Pressure grease lubrication in this manner is decidedly effective on certain steel mill machinery where the possibility of lubricant contamination and bearing wear may be great.

It is reasonable to expect that by virtue of average shackle construction, more or less of this objectionable foreign matter may work into such bearings to greatly increase the possibility of faulty lubrication and increased wear. It is practicable to prevent this, however, by regular lubrication and application of grease under sufficient pressure to force out all old lubricant plus any contaminating foreign matter. The extent to which this is being accomplished can be noted by watching the bearing ends. When fresh grease is forced through, as can be determined by its appearance, it is indication that the bearing clearance space has been properly re-filled with lubricant.

To some motorists this is an objectionable procedure for it involves wiping the shackle free of dust and old lubricant. Furthermore, to do the job properly a slight bulge of fresh grease should be present. They will argue that this serves as a dust catcher, and perhaps gives their car a sloppy appearance. The latter is unnecessary, however, for with due care in greasing, this exterior bulge of grease should be virtually unnoticeable. But they should never regard the dust retaining function of grease as an objection. It is a most effective means of sealing and protecting their spring shackle bolts against wear, and decided insurance that comfortable, noiseless and economical car riding will be maintained.

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